SACRAMENTO STORMWATER QUALITY PARTNERSHIP

Sacramento Stormwater Quality Partnership

including the County of Sacramento and the cities of Sacramento, Citrus Heights, Elk Grove, Folsom, Galt, and Rancho Cordova

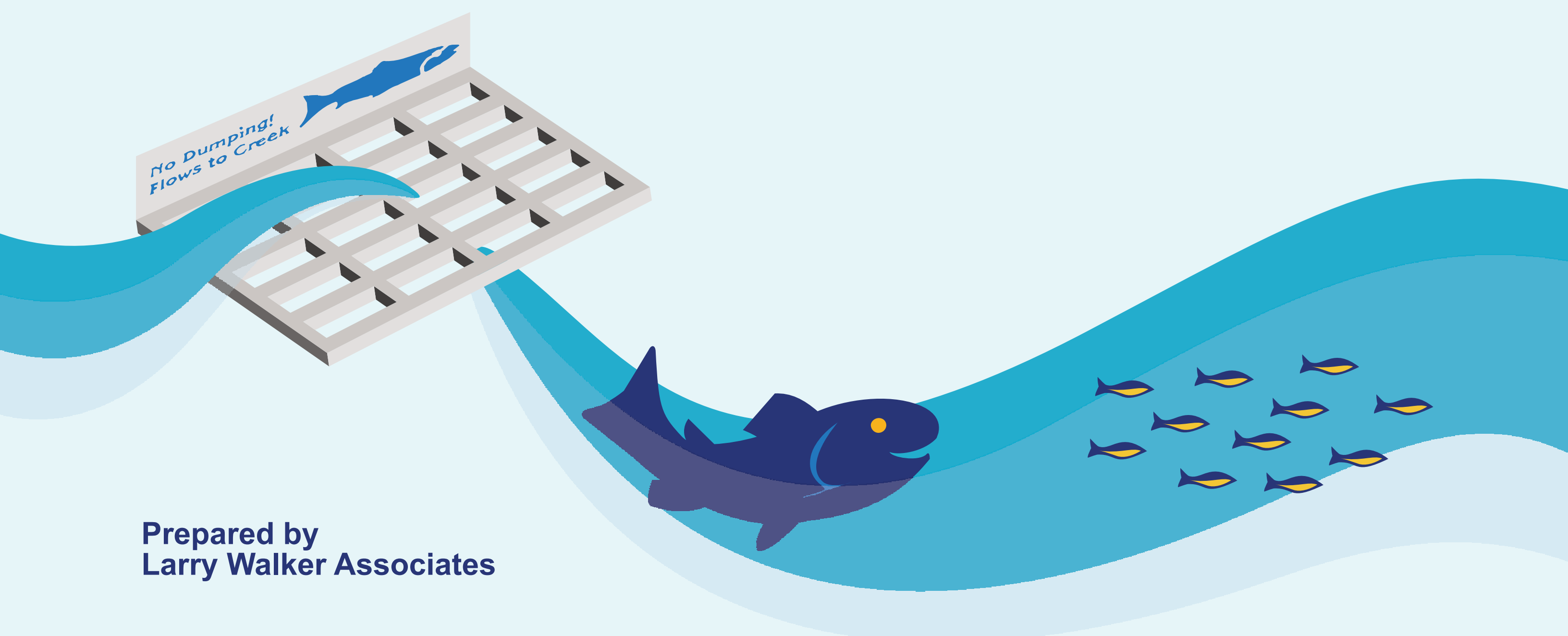
Delta Methylmercury

TOTAL MAXIMUM DAILY LOAD CONTROL PROGRAM IMPLEMENTATION

Phase I Control Study Work Plan

April 19, 2013

REVISED October 11, 2013



Prepared by
Larry Walker Associates

Submitted to:

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Central Valley Region, 11020 Sun Center Drive #200, Rancho Cordova, CA 95670-6114

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Phase I Control Study Work Plan

Primary contact person(s):

Hong Lin, (916) 808-1449, hlin@cityofsacramento.org

Dave Tamayo, (916) 874-8024, tamayod@SacCounty.net

Prepared by:

Larry Walker Associates

LARRY WALKER ASSOCIATES

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Appendix A. Map and Overview of Control Study Locations

Several study reports prepared by the Sacramento Stormwater Quality Partnership are referenced in this document, but are not included as appendices because of their length. The following referenced documents are available upon request or for download as noted below:

Larry Walker Associates. *Urban Runoff Discharge and Receiving Water Quality Assessment Report, Technical Memorandum*. March 2013. [Included as an attachment to the Report of Waste Discharge (ROWD) submitted to the Regional Board.]

http://www.dropbox.com/s/s9tsix4xrr3syxk/LWA-2013-Water-Quality-Assessment-Memo-Final.pdf

Larry Walker Associates. *Additional Total Mercury and Methylmercury Analyses Memorandum.* September 2009.

https://www.dropbox.com/s/rw438au5iu6rqf4/LWA-2009-Additional-Hg-Analyses.pdf

Jennifer J. Walker, P.E., D.WRE, CFM , Watearth. *Low Impact Development (LID) Demonstration Project and Modeling Analysis for Sylvan Community Center. Memorandum of Modeling Results.* May 7, 2012.

https://www.dropbox.com/s/9b1nxu9tg3n7xer/Watearth-2012-Citrus-Heights-LID-FINAL-Modeling-Memorandum-for-Sylvan-Site.pdf

List of Acronyms

ANOVA	Analysis of Variance
BMP	Best Management Practice
CEDEN	California Data Exchange Network
DOC	Dissolved Organic Carbon
LID	Low Impact Development
LTEA	Long Term Effectiveness Assessment
MS4	Municipal Separate Storm Sewer System
ROWD	Report of Waste Discharge
TAC	Technical Advisory Committee
TMDL	Total Maximum Daily Load
WLA	Wasteload Allocation
WTM	Watershed Treatment Model
NPDES	National Pollutant Discharge Elimination System
QA/QC	Quality Assurance/Quality Control

Introduction

The Sacramento Stormwater Quality Partnership (Partnership)[1] developed this Methylmercury Control Study (Study) to evaluate the effectiveness and feasibility of measures to control methylmercury discharges in urban runoff and meet the waste load allocation (WLA) required under the Sacramento-San Joaquin Delta Estuary Total Maximum Daily Load (TMDL) for Methylmercury. This Work Plan provides technical details for the proposed Study for review by the Central Valley Regional Water Quality Control Board (Regional Water Board) and the Technical Advisory Committee (TAC) and is prepared according to the Methylmercury Control Study Guidance[2] and TAC comments on the Sacramento Stormwater Methylmercury Control Study Concept Proposal[3]. Requirements from the Methylmercury Control Study Guidance are included at the beginning of each section of this Work Plan.

The original Concept Proposal proposed to evaluate a wide range of control studies and modeling techniques to determine the level of implementation needed to meet the final WLA. While this activity may still be necessary as part of Phase I of the TMDL implementation, the TAC requested that the Partnership focus on one technical study based on an understanding and assessment of available control strategies, existing control studies, and coordination with other municipal separate storm sewer system (MS4) agencies included in the TMDL. Low impact development (LID) was identified by the Partnership as the control measure that can be most widely implemented in areas of new development and redevelopment and provide reductions in the total loading of methylmercury, primarily through volume reductions.

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[1] The Partnership agencies are subject to the Sacramento Area-wide MS4 NPDES Stormwater Permit (NPDES No. CAS082597). The Partnership agencies are the County of Sacramento and the cities of Citrus Heights, Elk Grove, Folsom, Galt, Rancho Cordova and Sacramento.

[2] Central Valley Regional Water Quality Control Board. *Methylmercury Control Study Guidance for the Delta Methylmercury Control Program Implementation Phase I.* May 2012.

[3] Larry Walker Associates (LWA). *Sacramento Stormwater Methylmercury Control Study: Preliminary Concept Proposal*. August 2012.

1.0 Problem Statement

Identify the Delta hydrologic subarea that you are addressing, the percent reduction in methylmercury needed for that subarea, and whether the activity that will be addressed is an existing activity, a new project, or both. Briefly state how your management activity may affect methylmercury production and export.

In the March 2013 Report of Waste Discharge (ROWD), the Partnership estimated that the urbanized service area (i.e., MS4 permitted urban area) is approximately 180,450 acres.[4] This estimate is based on the 2010 Farmland Mapping Data reported by the Department of Conservation.[5] The TMDL methylmercury WLA of 1 gram per year (g/yr) assumes a 44% reduction in current load discharged and applies only to a subarea of the total MS4 permitted urban area identified in the TMDL (4,766 acres[6]) that is within the legal definition of the Sacramento - San Joaquin River Delta. The WLA appears to cover only the permitted urban area within the legal boundary of the Delta, and not the tributary area upstream. Although the WLA applies to 2.6% of the total permitted urban area, Partnership control strategy efforts would more generally apply to this entire permitted urban area. Some of these areas will be subject to other future TMDL efforts in the American River and Sacramento River upstream of the 'I' Street Bridge.

MODELING RESULTS AND LOADING ESTIMATES

The Partnership performed monitoring data analysis and load modeling as part of the ROWD[7] and is discussed in more detail in Section 3.0.

Figure 1 shows the results from that continuous simulation modeling over a 30 year climatic record for current urban runoff conditions and assuming that the total area results can be scaled down to the Delta subarea.

The regression-based simulation considers storm and antecedent conditions as well as land use types, but does not directly consider mechanical (i.e., build-up and wash off), chemical, photosynthetic, or soil interaction processes. This empirical historical modeling approach incorporates ten years of high quality methylmercury urban runoff concentration data. The model outputs generally support the TMDL Staff Report load estimate findings. The average of the thirty year simulation period is approximately 1 gram per year (Table 3); however, year-to-year variation can be significant as the standard deviation of model results is 0.19 grams per year.

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[4] Sacramento Stormwater Quality Partnership. *Report of Waste Discharge*. Submitted to the Central Valley Regional Water Quality Control Board. March 15, 2013.

[5] http://www.conservation.ca.gov/dlrp/fmmp/Pages/Index.aspx

[6] Central Valley Regional Water Quality Control Board. *Delta Methylmercury TMDL Staff Report*. Page 110, Table 6.10. April 2010.

[7] Larry Walker Associates. *Urban Runoff Discharge and Receiving Water Quality Assessment Report, Technical Memorandum*. March 2013. Included as an attachment to the Report of Waste Discharge (ROWD) submitted to the Regional Board. <https://www.dropbox.com/s/s9tsix4xrr3syxk/LWA-2013-Water-Quality-Assessment-Memo-Final.pdf?m>

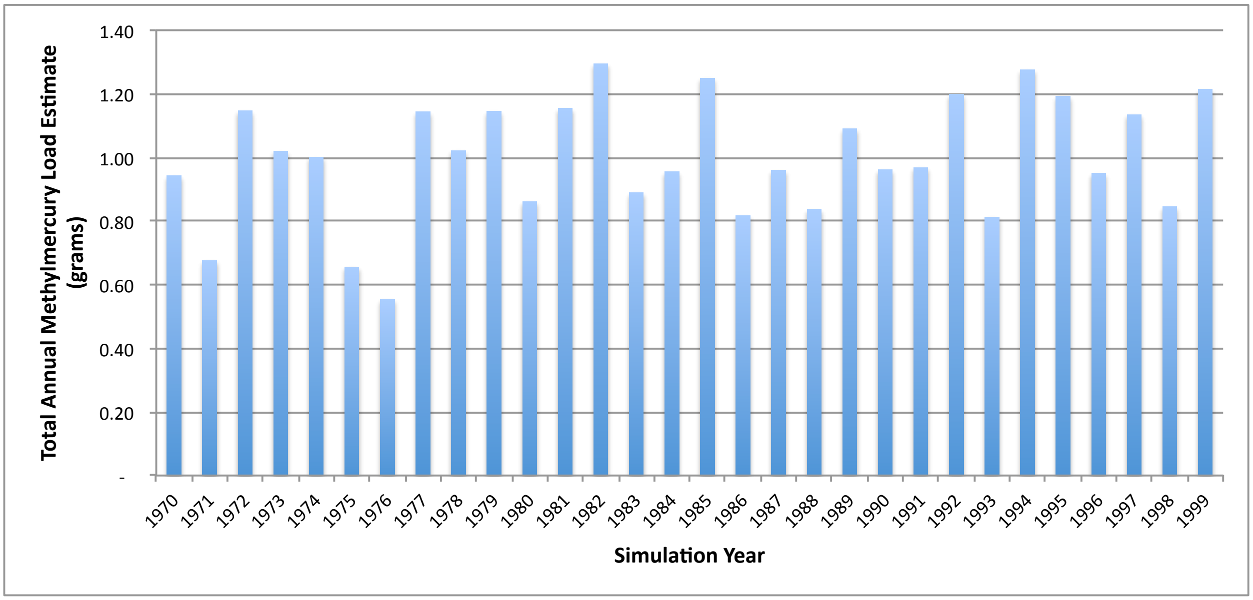

Figure 1. Methylmercury Annual Loading Estimate from Permitted Urban Area within Legal Delta Subarea [based on 2.6% fraction of total permitted urban area average]

PROPOSED CONTROL STRATEGY EVALUATION

This Work Plan evaluates LID measures as Best Management Practices (BMPs) for methylmercury control at two projects in Citrus Heights, California, a Partnership member and National Pollutant Discharge Elimination System (NPDES) Co-Permittee. This Work Plan describes an evaluation of both an existing LID redevelopment site and a new project to retrofit a public facility with LID features. This Work Plan is coordinated with the Proposition 84 implementation funding for the construction and monitoring of the Citrus Heights City Hall Complex and parking facilities (City Hall Complex). The second study location is the existing Sylvan Community Center (Sylvan Center) LID site and an adjacent non-LID development area that drains through the Sylvan Center.

This Work Plan proposes to compare LID urban runoff quality and loading per acre to the non-LID runoff sites as paired samples, when possible. In addition to data collection as part of the study, the Work Plan proposes to also use historic data collected by the Partnership at new development and older development areas for baseline comparisons, which would involve a distributional assessment and not a paired sample assessment. Estimates of annual loadings per acre will also be compared for quantitative differences.

The Study will assess whether the LID BMPs being studied reduce the export of methylmercury in urban runoff. The primary mechanisms for the expected reduction will be the reduction of off-site flow volume and increase in on-site sequestration of methylmercury in the LID medium (e.g., soil), since LID BMPs are designed to more rapidly infiltrate urban runoff by increasing the soil hydraulic conductivity and reducing drainage slopes to allow infiltration time. It is expected that the hydrology and subsurface conditions in the medium of the LID BMPs will prevent the mercury species sequestered there from being released to surface waters in significant amounts, during the rare events in which surface runoff downstream of the LID occurs.

Determining removal efficiency using traditional control structure inlet-outlet water quality monitoring is difficult and not especially relevant for LID projects. Inlet flows are often distributed through the length of a structure (e.g., a bioswale[8]) at low flow rates or as sheet flow, and measuring flow rates and sample collection is difficult. Moreover, LID features are designed to minimize outflow volume. For these reasons, the proposed Work Plan focuses on accurate quantification of outflow volume and concentration compared to non-LID urban runoff. This Work Plan proposes to use a combination of continuous sensors and grab samples collected manually or with automated samplers.

WATERSHED SCALE-UP OF CONTROL MEASURES

LID features comprise a fraction of the many BMPs that exist for managing stormwater runoff in urban areas. Currently, new development and redevelopment priority projects in the Partnership service area are required to implement LID.[9] Compliance with the WLA will require a combination of structural control strategy implementation (e.g., retrofit or redevelopment) throughout the drainage area and other non-structural source control strategies (e.g., street sweeping, household hazardous waste management, public outreach, etc.).

Accurately quantifying the discharged load and effectiveness of Partnership programs and controls is complicated by the high number of variables involved in modeling the load (e.g., estimated runoff volume or flow, effects of flow calibration, monitoring conditions and results from water quality characterization), the large number of stormwater discharge locations, and other uncontrollable factors (e.g., year-to-year fluctuations in methylmercury levels), especially at the low WLA (1 gram per year). The Work Plan investigates only one type of urban runoff control measure (LID) that is expected to have increasing influence on urban runoff quality through new development and redevelopment. The Partnership has already evaluated total mercury and methylmercury removal efficiency of wet detention basins and non-structural controls such as street sweeping and hazardous waste disposal programs.

2.0 Objectives

To the extent possible, provide objectives that are specific, measurable, and relevant to the TMDL, for: 1) the study activity (i.e., experiments, evaluations, and/or modeling) that will be conducted and 2) application of the study results to your ultimate goal of methylmercury control.

a. *Study objective: What hypotheses do you plan to test with your study? Clearly state your hypotheses in a manner that focuses on the mechanism(s) by which your control measure may contribute to the control objective.*

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[8] Swaled drainage course with gently sloping vegetated sides, designed to remove silt and potential pollutants from first flush of surface runoff water

[9] See priority project definition (Table 3-2) in the *Sacramento and South Placer Regions Stormwater Quality Design Manual* (May 2007)

b. *Control Objective: Describe your total allocation responsibility. Demonstrate how your control measure could be applied, scaled-up or combined with other control measures to achieve the methylmercury allocation.*

The overarching goal of the Work Plan is to contribute to decreases of methylmercury loads to the Delta. Study results will be used in TMDL compliance and feasibility assessments. The proposed data collection should enhance existing data assumptions used in Partnership estimates of methylmercury load discharged and removed in comparison to baseline "control" locations and historical Partnership data for older urban development.

STUDY OBJECTIVE

The Study objective is to test the following hypothesis:

H_1: On a load per area basis, LID features reduce methylmercury discharged to the MS4 and receiving waters, in comparison with non-LID urban areas.

Proposed Work Plan activities include water quality sample collection, sample analysis, and data evaluations for the purpose of testing the hypothesis.

CONTROL OBJECTIVE

The Partnership TMDL methylmercury WLA is 1 gram per year for the area within the legal boundary of the Delta. This is a 44% percent reduction in current load as estimated in the TMDL, (see Section 1). The control objective is to evaluate both the effectiveness of using LID features as a methylmercury control measure and the feasibility of complying with the WLA. Specific LID features at the project locations in the proposed Work Plan include:

- Pervious pavement/ permeable pavers
- Subsurface retention systems
- Bioswales
- Vegetated swales
- Vegetated buffer strips
- Rain gardens
- A rain barrel
- Native/drought tolerant vegetation.

The above LID features are incorporated into the proposed Work Plan study areas and could be adapted for use at other applicable locations (residential, commercial development and municipal roadway projects) and expanded to include additional site-specific LID practices (e.g., soil amendments, roof downspouts disconnection). LID practices, though subject to limitations in implementation (e.g., due to site specific constraints, cost-effectiveness), may be applied to new development, redevelopment, as retrofits to existing development, high density ultra-urban settings, open spaces, environmentally sensitive locations, and various features of the landscape (e.g., buildings, roads, walkways, and yards) if appropriate.

Although removal of other metals and pollutants by BMPs has been studied, removal of methylmercury with LID and other control strategies is not well documented in literature and available BMP databases.[10] This proposed Work Plan will examine and evaluate the methylmercury removal or load reduction of LID compared to older urban development and then estimate projected reductions for areas of future implementation. This proposed Work Plan will evaluate the feasibility of control strategy scale-up to larger drainage areas to comply with the methylmercury WLA.

Following the field studies in this Work Plan, the effect of scaling-up of LID control measures throughout the larger urban runoff area will be modeled to estimate the feasibility of compliance through implementation of LID control measures and other better documented control strategies evaluated by others (e.g., Stockton and Contra Costa MS4s) or through existing Partnership studies (e.g., wet detention basin evaluations). The Partnership has previously performed this scale-up of control measure load reductions of total mercury with the Center for Watershed Protection Watershed Treatment Model (WTM) and intends to use a similar approach for methylmercury with this newly acquired data.

3.0 Mechanisms Underlying the Study

Provide a conceptual model or set of underlying assumptions to support your hypotheses and explain why or how your proposed control study will achieve the study and control objectives.

CONCEPTUAL MODEL

The transformation from elemental mercury to methylmercury, the most toxic form of mercury, is a complex biogeochemical process. As a likely source of mercury to urban runoff, atmospheric deposition contributes elemental forms, reactive gaseous forms (e.g., inorganic divalent mercury), and particulate forms of mercury to surface waters[11] and to surfaces where stormwater can mobilize particles and equilibrate water column concentrations (i.e., "build-up and wash-off"). Once in surface waters or in wetted soils, mercury enters a complex cycle in which methylation can occur and one form of mercury can be converted to another. Mercury attached to particles can settle into the sediment where it can diffuse into the water column, be re-suspended, or be buried by other sediments. Mobilized methylmercury can enter the food chain or be released back to the atmosphere by volatilization as a result of exposure to ultra-violet rays from sunlight.[12]

The concentration of dissolved organic carbon (DOC) and pH has a strong effect on the fate of mercury in an ecosystem. Increasing the acidity and/or the DOC concentration of the water appears to cause greater net methylation and enhancement of mercury mobility in the environment.[12] Specifically, the DOC to total dissolved mercury ratio appears to be positively correlated to net methylmercury production and might be a more important factor for net methylation of mercury than DOC alone. Redox variations also seem to indirectly affect mercury

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[10] International BMP Database (http://www.bmpdatabase.org/)

[11] Butler, T.; et al. January 2007. *Final Report, Mercury in the Environment and Patterns of Mercury Deposition from the NADP/MDN Mercury Deposition Network.*

[12] U.S. Geological Survey (USGS). October 2000. *Mercury in the Environment, Fact Sheet 146-00.*

methylation and mobilization through related changes in DOC, sulfur cycle, and soil microbial community structure.[13]

LID features are designed to mimic natural physical, chemical, and biological processes. Physical processes include increased interception, infiltration, and evapotranspiration; facilitation of sediment removal, filtration, and volatilization; and stabilization of soils to reduce sedimentation and erosion. Chemical processes include facilitation of adsorption, chelation, ion exchange, and organic complexing. Additionally, biological processes include increased transpiration, nutrient cycling, direct uptake, and microbial decomposition.[14, 15] Ideally, methylmercury adheres to solids and is not remobilized or is photodegraded. Conditions that generate methylmercury in the near surface soils of an LID feature (e.g., a bioswale) are not expected to exist; however, the proposed Work Plan only examines the net export of methylmercury. Additional studies may be conducted to evaluate the near surface soil conditions.

LID practices often have built-in redundancy through distributed and serial arrangement. With this redundancy, if one LID practice in a suite of LID practices is ineffective and/or removed at a particular site, the rest of the LID practices should still be functional and achieve an increased capture volume and treatment level relative to sites without any LID features. Moreover, sizing and placement of LID features is unique to a site in order to maximize their efficiency and reduce cost. The proposed Work Plan evaluates the overall performance of multiple LID features at two sites rather than individual components. Evaluating two sites allows for comparisons in the assumption that the unique groupings of LID features will not significantly affect the per acre loading of methylmercury from LID sites.

LID removal efficiencies for heavy metals, including total mercury, appear to be good. Removal efficiency for such constituents appears to be directly related to the removal rate of total suspended solids (TSS) and suspended sediment concentration (SSC). Accordingly, the soil contained in LID features may need to be tested and replaced when soil fertility is lost (e.g., within 10 years of construction) since substances in runoff eventually disrupt normal soil functions by lowering the cation exchange capacity, or the ability of the soil to adsorb pollutant particles through ion attraction. Additional studies may be conducted to evaluate the cation exchange capacity of soil contained in LID features.

STUDY AND CONTROL OBJECTIVES

The proposed Work Plan will test the hypothesis, H_1 with an experimental study at two LID locations. The proposed Work Plan will achieve the control objective using the study data collected as part of this proposed Work Plan, data collected by other MS4 agencies, and data collected in previous Partnership studies to evaluate the relative benefit of different control strategies and to quantify reasonable estimates of potential urban runoff methylmercury load reductions throughout the TMDL area and the broader permitted urban area.

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[13] Frohne, T.; et al. January 2012. *Biogeochemical factors affecting mercury methylation rate in two contaminated floodplain soils*. Biogeosciences, 9, 493–507.

[14] Natural Resources Defense Council (NRDC). October 2001. *Stormwater Strategies, Community Responses to Runoff Pollution, Chapter 12: Low Impact Development*.

[15] Department of Environmental Resources: Programs and Planning Division. June 1999. *Low-Impact Development Design Strategies: An Integrated Design Approach*. Prince George's County, Maryland.

The study objective will be achieved in the following manner:

- Monitor urban runoff conditions at representative non-LID developments (prior to redevelopments) and two LID redevelopments,
- Accurately measure the volume of urban runoff exported (discharge to storm drain inlets) from the study sites,
- Collect methylmercury and supporting water quality samples to accurately measure the concentration of urban runoff exported from the study sites, and
- Quantify differences in per acre loading from LID and non-LID sites.

The control objective will be achieved in the following manner:

- Update Watershed Treatment Model to consider methylmercury, new study information, and already implemented control strategies;
- Develop implementation scenarios of evaluated control strategies to determine the required control strategies to comply with the WLA;
- Develop achievable implementation schedules and cost estimates for the required control strategies based on expected rates of redevelopment within the TMDL urban area; and
- Prepare an evaluation of the overall feasibility of complying with the WLA.

The results from implementing the study and control objectives will allow the Partnership to better understand the effectiveness and feasibility of using LID to reduce methylmercury discharge to the Delta, and to determine potential next steps in regional methylmercury management for the purpose of meeting the WLA and/or reducing the discharge load to the maximum extent practicable.

SUMMARY OF EXISTING AQUEOUS METHYLMERCURY CONCENTRATIONS AND LOADS FROM URBAN RUNOFF

The Partnership has collected methylmercury concentration in urban runoff, urban tributary, and river locations four to five times annually for more than ten years. The Partnership collected for both dry and wet weather samples, including the seasonal first flush event. A summary of the historical results as provided in the ROWD is provided in Table 1 on page 10. New development areas, as represented by the North Natomas Detention Basin urban runoff site,[16] have implemented new development treatment standards and show consistently lower discharged concentrations of total mercury and methylmercury compared to older development. However, operation of the wet detention basins has not been evaluated to identify conditions that may increase methylmercury production. Sampling events include the seasonal first flush and a wide range of other conditions.

The Partnership performed load modeling as part of the ROWD[7] for all constituents of concern including methylmercury, although this assessment was performed for the entire permitted urban area rather than the drainage within the legally defined Delta.

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[16] Briefly outlined on page 26 of *Additional Total Mercury and Methylmercury Analyses Memorandum* (LWA, 2009) <https://www.dropbox.com/s/rw438au5iu6rqf4/LWA-2009-Additional-Hg-Analyses.pdf>

A factor analysis was performed on concentrations and contributing antecedent and storm factors (e.g., days since last storm, event rainfall, etc.) to develop regression equations estimating concentrations of constituents for a specified storm event. A continuous thirty year rainfall record of these factors was used to run a simulation model for the current urban area (2010 Farmland Mapping Program data) and most recent urban runoff water quality concentrations (2002-2012).

Flow volume discharge was estimated using the rainfall record and a rational method flow model that was calibrated to the Arcade Creek at Del Paso drainage. Historically, the Partnership has used an empirical rainfall-runoff regression to model the volume component of discharged load. The rational method and the curve number method (CN-method) were evaluated based on recommendations in previous Partnership load assessments. All three methods of modeling flow volumes are based on the simulation period rainfall. The calibrated rational method was selected for load estimate calculations. A summary of total mercury and methylmercury load estimates is provided in Table 3 and Table 4.

Table 1. Summary of Historical Methylmercury Aqueous Concentrations

Methyl mercury, total (ng/L)			All Events						Dry Weather						Wet Weather					
	Site Code	Site Description	n	%det	med	st dev	min	max	n	%det	med	st dev	min	max	n	%det	med	st dev	min	max
All Data (Dec 2002 - June 2012)	AC03	Arcade Ck at Watt Ave	20	100%	0.44	0.39	0.15	1.40	3	100%	0.27	0.05	0.24	0.33	17	100%	0.48	0.40	0.15	1.40
	LC02	Laguna Ck at Hwy 99	14	100%	0.20	0.12	0.09	0.49	3	100%	0.30	0.19	0.13	0.49	11	100%	0.17	0.07	0.09	0.33
	MC01	Morrison Ck at Brookfield	4	100%	0.47	0.06	0.39	0.53	0	-	-	-	-	-	4	100%	0.47	0.06	0.39	0.53
	UR2S	Strong Ranch Slough	32	100%	0.32	0.56	0.07	2.23	11	100%	0.13	0.58	0.07	2.04	21	100%	0.52	0.51	0.20	2.23
	UR3	Sump 111	32	100%	0.28	0.28	0.09	1.07	11	100%	0.22	0.28	0.09	1.07	21	100%	0.32	0.28	0.11	1.05
	UR4	Sump 104	20	100%	0.17	0.17	0.05	0.61	8	100%	0.09	0.03	0.05	0.15	12	100%	0.28	0.17	0.15	0.61
	UR5 STA2	N Natomas Det Basin No. 4	11	100%	0.16	0.07	0.10	0.31	3	100%	0.15	0.05	0.15	0.23	8	100%	0.15	0.08	0.10	0.31
	WC01	Willow Ck at Blue Ravine	21	95%	0.25	0.29	ND	1.10	4	100%	0.11	0.03	0.09	0.14	17	94%	0.30	0.30	ND	1.10
	Site Code	Site Description	n	%det	med	st dev	min	max	n	%det	med	st dev	min	max	n	%det	med	st dev	min	max
Permit Term Only (Oct 2008 - June 2012)	AC03	Arcade Ck at Watt Ave	15	100%	0.37	0.36	0.15	1.32	3	100%	0.27	0.05	0.24	0.33	12	100%	0.40	0.39	0.15	1.32
	LC02	Laguna Ck at Hwy 99	14	100%	0.20	0.12	0.09	0.49	3	100%	0.30	0.19	0.13	0.49	11	100%	0.17	0.07	0.09	0.33
	MC01	Morrison Ck at Brookfield	0	-	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-
	UR2S	Strong Ranch Slough	12	100%	0.41	0.67	0.08	2.23	3	100%	0.09	0.01	0.08	0.10	9	100%	0.68	0.67	0.28	2.23
	UR3	Sump 111	12	100%	0.46	0.31	0.16	1.07	3	100%	0.59	0.36	0.42	1.07	9	100%	0.42	0.31	0.16	1.05
	UR4	Sump 104	0	-	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-
	UR5 STA2	N Natomas Det Basin No. 4	11	100%	0.16	0.07	0.10	0.31	3	100%	0.15	0.05	0.15	0.23	8	100%	0.15	0.08	0.10	0.31
	WC01	Willow Ck at Blue Ravine	16	94%	0.21	0.28	ND	1.10	4	100%	0.11	0.03	0.09	0.14	12	92%	0.26	0.30	ND	1.10

Table 2. Summary of Historical Total Mercury Aqueous Concentrations

Mercury, total (ng/L)			All Events						Dry Weather						Wet Weather					
	Site Code	Site Description	n	%det	med	st dev	min	max	n	%det	med	st dev	min	max	n	%det	med	st dev	min	max
All Data (Feb 1990 - June 2012)	AC03	Arcade Ck at Watt Ave	20	100%	19.0	26.1	2.46	101	3	100%	3.4	0.9	2.46	4.29	17	100%	25.7	25.7	6.51	101
	LC02	Laguna Ck at Hwy 99	14	100%	4.0	2.4	1.59	8.49	3	100%	3.4	3.4	1.7	8.04	11	100%	4.2	2.3	1.59	8.49
	MC01	Morrison Ck at Brookfield	4	100%	24.3	13.6	12.2	42.8	0	-	-	-	-	-	4	100%	24.3	13.6	12.2	42.8
	UR2S	Strong Ranch Slough	46	100%	23.8	200.5	3.07	1137.9	16	100%	5.7	20.0	3.07	84	30	100%	50.9	240.3	9.68	1137.9
	UR3	Sump 111	57	86%	17.5	64.1	ND	400	19	84%	6.3	7.8	ND	28.96	38	87%	29.2	75.4	ND	400
	UR4	Sump 104	45	84%	13.1	65.8	ND	400	16	88%	4.6	49.0	ND	200	29	83%	24.1	72.8	ND	400
	UR5 STA2	N Natomas Det Basin No. 4	12	100%	3.1	3.1	1.1	13	3	100%	1.6	0.8	1.1	2.6	9	100%	3.8	3.3	2.4	13
	WC01	Willow Ck at Blue Ravine	21	100%	16.1	29.0	1.27	110	4	100%	2.6	1.0	1.27	3.58	17	100%	24.7	29.1	3.23	110
	Site Code	Site Description	n	%det	med	st dev	min	max	n	%det	med	st dev	min	max	n	%det	med	st dev	min	max
Permit Term Only (Oct 2008 - June 2012)	AC03	Arcade Ck at Watt Ave	15	100%	13.2	16.0	2.5	52.9	3	100%	3.4	0.9	2.5	4.3	12	100%	18.6	15.6	6.5	52.9
	LC02	Laguna Ck at Hwy 99	14	100%	4.0	2.4	1.6	8.5	3	100%	3.4	3.4	1.7	8.0	11	100%	4.2	2.3	1.6	8.5
	MC01	Morrison Ck at Brookfield	0	-	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-
	UR2S	Strong Ranch Slough	12	100%	20.6	25.2	3.1	77.4	3	100%	3.9	1.3	3.1	5.5	9	100%	36.0	22.0	17.0	77.4
	UR3	Sump 111	12	100%	24.0	21.2	6.3	72.3	3	100%	12.8	11.0	6.3	27.5	9	100%	29.6	21.8	8.5	72.3
	UR4	Sump 104	0	-	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-
	UR5 STA2	N Natomas Det Basin No. 4	12	100%	3.1	3.1	1.1	13.0	3	100%	1.6	0.8	1.1	2.6	9	100%	3.8	3.3	2.4	13.0
	WC01	Willow Ck at Blue Ravine	16	100%	11.9	19.7	1.3	78.7	4	100%	2.6	1.0	1.3	3.6	12	100%	19.9	19.6	3.2	78.7

Table 3. Sacramento Permitted Urban Area (180,450 acres) Annual Urban Runoff Loading Estimates

Constituent	Loading Units	Mean	Standard Deviation	Coeff. of Variation	Min.	Max.
Total Mercury	kg	3.5	1.2	0.35	1.3	6.7
Methyl Mercury	g	38[1]	7.2	0.19	21	49
Flow	MCF	5,738	1,415	0.25	3,291	9,275

[1] Based on the approximate area to which the WLA applies (2.6% of the Sacramento permitted urban area), the fraction of methylmercury discharged to the Delta is estimated at 0.988 grams per year.

Table 4. Sacramento Permitted Urban Area (180,450 acres) Average Annual Urban Runoff Loading by Season Type

Constituent	Units	Storm Events	Inter-Storm Wet Season	Dry Season	Total Average Annual
Total Mercury	kg	3.2	0.16	0.10	3.46
Methylmercury	g	28	6.1	3.9	38
Flow Volume	MCF	3,384	1,435	918	5,738

FACTORS AFFECTING METHYLMERCURY LEVELS

The sources of methylmercury in urban runoff are generally widely distributed and include atmospheric deposition, combustion, and improper hazardous materials disposal and handling. Factors affecting methylmercury within the Partnership source area include seasonal build-up and wash off dynamics, site-specific conditions (e.g., soil type), atmospheric transport patterns, and wetting and drying cycles of exposed soils. Annual loads are expected to fluctuate with rainfall volume.

While seasonal first flush events have higher concentrations of pollutants, they occur at times when soils are not saturated and LID features should have capacity to infiltrate volumes from all but the largest storm events.

LID features are designed to reduce overland flow and minimize discharge volume. Based on flow volume modeling performed for the Sylvan site,[17] few outflow events are expected. Storms with higher overland flow depths are likely to result in larger methylmercury discharge volumes and loads at the LID sites. Heavier precipitation and/or longer periods of precipitation are needed for LID outflow and to provide necessary conditions for LID outflow monitoring (e.g., sufficient flow).

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[17] Jennifer J. Walker, P.E., D.WRE, CFM , Watearth. *Low Impact Development (LID) Demonstration Project and Modeling Analysis for Sylvan Community Center*. *Memorandum of Modeling Results*. May 7, 2012. <https://www.dropbox.com/s/9b1nxu9tg3n7xer/Watearth-2012-Citrus-Heights-LID-FINAL-Modeling-Memorandum-for-Sylvan-Site.pdf>

4.0 Proposed Control Measures

Describe how the study will be designed to test the hypothesis and conceptual models as described in the sections for Objectives and Mechanisms Underlying the Study. Explain whether the measure is targeted research, a pilot project, or larger in scope. If the project is targeted research, explain why the targeted research cannot be incorporated into a pilot project. If you are proposing a measure that is large in scope, describe the level of risk and how potential negative impacts could be managed or reversed.

To test the hypothesis and address the control objective, the Partnership will conduct an LID implementation study pilot project. The Partnership will monitor and compare methylmercury concentrations and exported loads at the two locations for LID and non-LID runoff. During the wet season (October through April) of the first study year, baseline urban runoff monitoring data will be collected at each location. After the first year of monitoring and before the next wet season begins, one existing development location will be retrofitted to incorporate LID features (see Figure 6, Section 5.0 on page 20). In the second year of the study, at least one non-LID and two LID sites will be monitored. Monitoring will include grab sample and continuous data collection, potentially including composite sample collection if there is sufficient runoff or flow. The first year of monitoring will also test and optimize methods for collection of LID runoff samples. Refer to Section 5.0 for additional details on the monitoring and data collection for the proposed measures. Grant contracting requirements and construction delays may alter the monitoring schedule.

To test the hypothesis (H_1), methylmercury concentrations and flow at the outflow to the MS4 system will be compared between non-LID and LID conditions. Pre-development conditions will be measured prior to LID BMP installation, and throughout the study at the non-LID sites. H_1 is supported if paired event load comparisons using the Wilcoxon Signed-Rank Test demonstrate a statistically significant difference between LID site and non-LID site data. H_1 is also supported if the comparison between pre-LID and post LID conditions at the LID site demonstrate a statistically significant difference using distributional comparisons such as the Mann-Whitney test. Finally, total annual loading estimates will also be quantitatively and qualitatively compared.

Methylmercury, total mercury, reactive mercury, DOC, and additional constituents (see Section 5.0, Table 5 on page 14) will be analyzed with grab samples (manual or automated) collected during discharge events. If discharge events are too infrequent, supplemental "in-system" samples may be taken to assess "potential" discharge quality. With continuous probes (for flow and other parameters such as DOC, pH, and surrogates for methylmercury) and given sufficient urban runoff flow, the Partnership will develop pollutographs (concentration vs. time) for the monitored parameters to assess the variability of outflow water quality. Pollutographs will allow for greater accuracy when calculating total flow volume and mass loads.

All proposed monitoring sites are located within approximately 1 mile of each other (see Appendix A). Based on the results of the proposed monitoring, the LID features may be effective in reducing runoff flow and if implemented on a large scale in the watershed, may thereby support lowered methylmercury loading to the Delta. If feasible, the WLA may be achieved by implementing a combination of LID features in reducing flow and other source controls on a watershed scale.

5.0 Monitoring and Data Collection Plan

Identify parameters and media that will be measured and over what frequency and duration. Describe how these measurements will be used to determine the effectiveness of the control measure(s). Describe the statistical approach you will use to evaluate the results and compare outcomes with the hypotheses. Studies to assess the effects of water management on methylmercury may largely rely on methylmercury data already collected.

The Partnership will collect continuous probe data for flow volume and water quality to accurately quantify and compare outflow loadings from two LID sites and two non-LID sites. The Partnership will collect and analyze for water quality constituents in Table 5. Methylmercury and methylmercury indicator analyses are the highest priority if sample volume is limited. A summary of the proposed Study monitoring is given in Table 6 on page 15. The anticipated sampling points are shown in Figure 2, Figure 6, and Figure 7 on page 16, 20, and 21 respectively.

A v-notch weir will be necessary to accurately measure low outflow volumes and to provide sufficient sample collection depth. An auto-sampler may be used with multi-bottle capabilities and remote or programmed initiation. This will allow collection of discrete samples at a given frequency once a certain water depth is reached. Whereas the sensors will run continuously, the auto-sampler will be set up to collect grab samples in up to five selected storm events per monitoring year, though outflow may not occur that frequently. Additionally, manual grab samples may be taken to supplement and/or substitute for automated aliquots.

SAMPLE EVENT TARGETING

The Partnership will target periods of high rainfall over multiple days with the highest probability of generating outflow. To begin the study the Partnership will target events forecasted for more than one inch of rainfall in 24 hours or 1.5 inches in 48 hours. This targeting may be modified based on system performance and recorded flows.

If outflow volumes and durations are sufficient, the Partnership may consider collecting composite samples in addition to grab samples. Sample collection will be limited to five events annually for the two year Study and will be limited to cases where there is outflow from the locations. In the meantime, collection of flow and water quality data using sensors on-location will provide continuous data for evaluation.

Blank and duplicate samples will be collected as quality control samples. Along with the monitoring measurements and associated observations, general descriptions of the hydrologic and climatic conditions under which the Study is conducted will be recorded. Appropriate quality assurance/quality control (QA/QC) procedures, as presented in Section 6.0, will be followed during monitoring and lab analysis.

Table 5. Proposed Methylmercury Control Study Parameters and Monitoring Methods

Parameters	Monitoring Method	
	Grab sample	Continuous sensor
Methylmercury	✓	✓[1]
Total mercury	✓	
Total reactive mercury[2]	✓	
Flow		✓[3]
Turbidity	✓	✓
Water temperature	✓	✓
Dissolved oxygen	✓	✓
Electrical conductivity	✓	✓
pH	✓	✓
Redox		✓
Total suspended solids	✓	
Suspended sediment	✓	
Total dissolved solids	✓	
Total phosphorus	✓	
Total Kjeldahl nitrogen	✓	
Nitrate + Nitrite	✓	
Total organic carbon	✓	
Dissolved organic carbon	✓	✓[1]
Filtered and unfiltered metals[4]	✓	
Sulfate	✓	

[1] Fluorescence-based optical sensor directly measures dissolved organic matter to provide a high resolution proxy for dissolved organic carbon (DOC) and methylmercury concentrations (see Appendix D)
[2] Along with any other key speciation
[3] Depth sensor in combination with v-notch weir
[4] Cu, Ni, Pb, and Zn

SAMPLE COLLECTION LOCATIONS

Sample collection locations are the same at the Sylvan Center site for both years. At the City Hall Complex non-LID runoff samples will be collected in year No. 1 prior to the grant-funded retrofit project. After construction of the City Hall Complex LID project, LID urban runoff discharging to the MS4 will be sampled. The monitoring locations and expected schedule are shown in Table 6.

Table 6. Proposed Methylmercury Control Study Monitoring Locations

Study Year	Location	Development Type	Monitoring Point Identification Code[1]
Year 1	Sylvan Center	non-LID	SV-0
	Sylvan Center	LID	SV-LID
	City Hall Complex	non-LID	CH-0
Year 2	Sylvan Center	non-LID	SV-0
	Sylvan Center	LID	SV-LID
	City Hall Complex	LID	CH-LID

[1] Monitoring Point ID (see Figure 2, Figure 6, and Figure 7)

Sylvan Center

In study years No. 1 and No. 2 the Partnership anticipates collecting Sylvan site samples at the locations indicated in Figure 2 (SV-0 and SV-LID). Figure 3 shows a diagram of the general flow of urban runoff treatment at the Sylvan Center. The northern discharge point (SV-0) is the location to which the drainage area adjacent to the Sylvan Center discharges. The southwestern discharge point (SV-LID) is the location to which the Sylvan Center LID features drain (see Figure 4).

The SV-0 location is at the start of the vegetated swale that receives off-site runoff from the adjacent older development residential and commercial area. The bioswale drains to an inlet (see Figure 4) that connects directly to the MS4 drain inlet. The upper section of the bioswale will be sandbagged to allow temporary installation of a weir structure. SV-0 samples will be collected behind a weir installed on the drain inlet or directly from the flow over the weir.

The SV-LID location is at the end of a series of LID features and drains through an inlet to the same junction as the SV-0 flow where they comingle. SV-LID samples will be collected behind a weir installed on the drain inlet or directly from the flow over the weir.

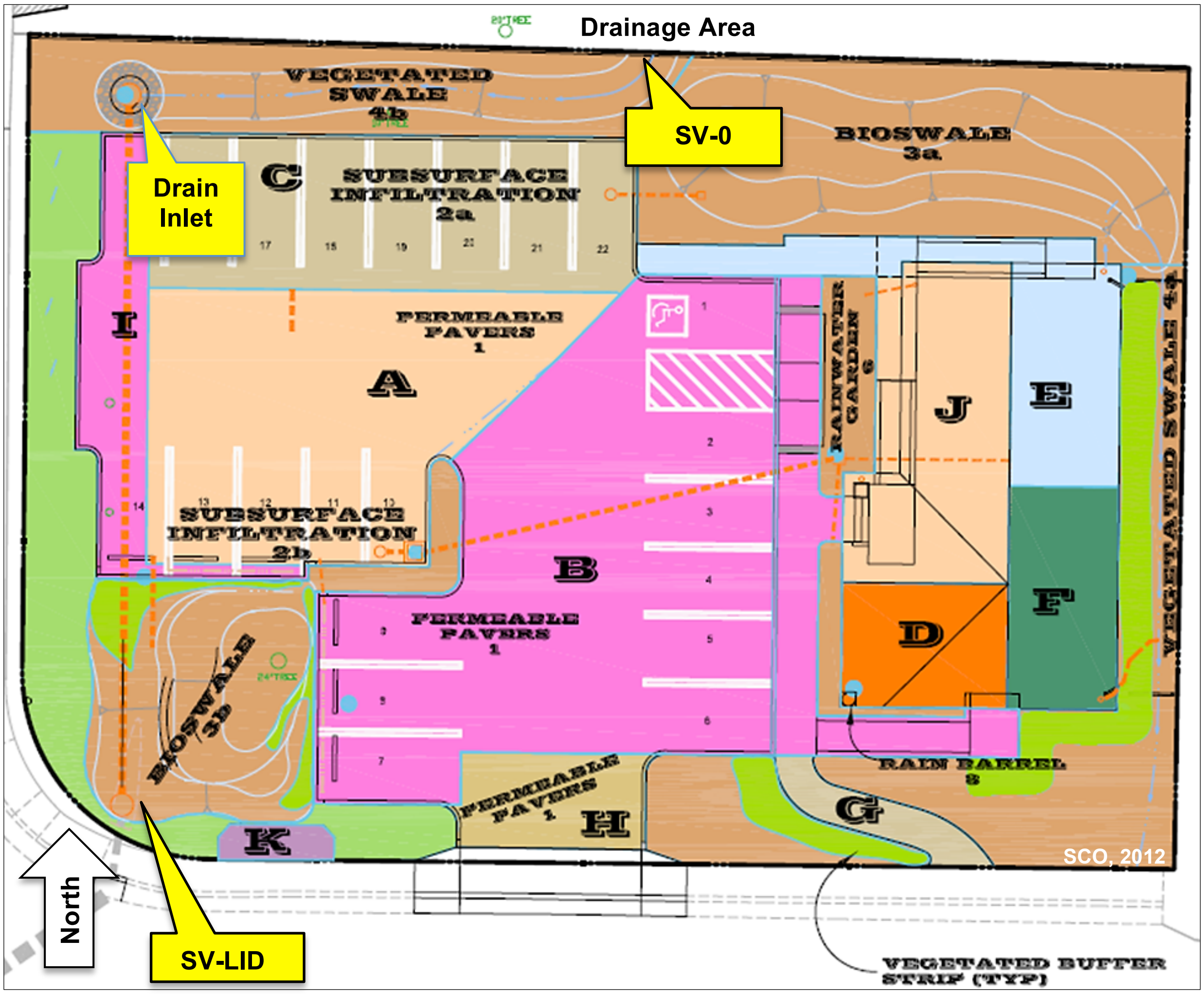

Figure 2. Sylvan Center Sampling Points

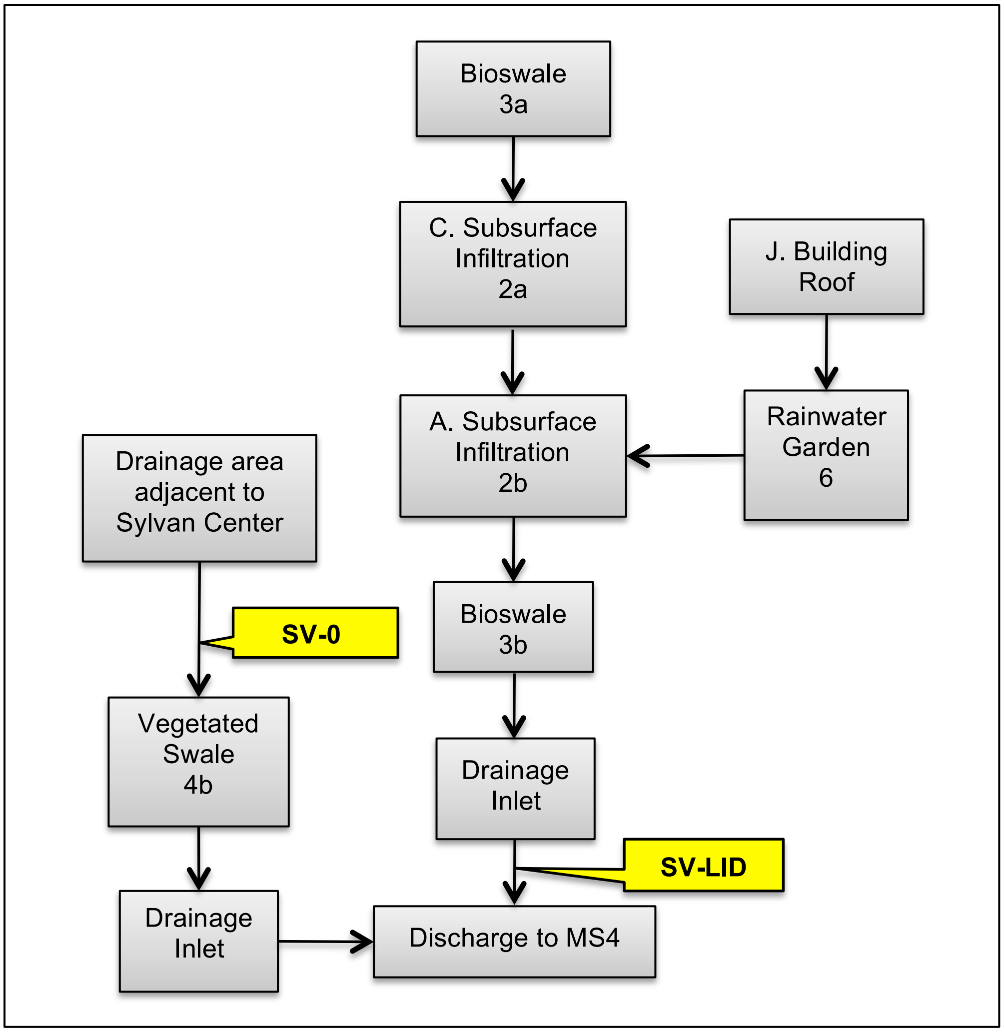

Figure 3. Process Schematic of Urban Runoff Treatment at Sylvan Center and Sampling Points

Figure 4. Sylvan Center Drain Inlet at end of Vegetated Swale that Receives Offsite Drainage [typical for connection to all drain inlets, shown in Figure 2]

City Hall Complex

The conceptual drawing in Figure 6 shows the preliminary sampling locations identified for the City Hall Complex site. The actual sites may change prior to initiation of sampling based on further field investigations and the yet completed final site design for the Proposition 84 funded LID implementation project.

In year No. 1 of the study the Partnership will collect non-LID samples from either a drain inlet, or upstream in the collection system below grade pipe. Access for this site (CH-0) will be through the drain inlet cover (see Figure 5) or a maintenance manhole cover. Two locations have been identified as shown in Figure 6 and Figure 7 as possible sample collection points. The actual sample collection point may change if an alternate location is easier to access and can be readily adapted for flow quantification and sample collection. However, the purpose of year No. 1 monitoring is to characterize pre-LID loading of methylmercury that is representative of the pre-redeveloped site in the Sacramento permitted urban area. The Partnership will verify the location of this site with a review of existing construction documents and field investigations prior to initiation of the study.

In year No. 2, or the first full or partial wet season following completion of construction, a location will be monitored prior to or at the point of outflow to the MS4 (CH-LID), following the bioswale LID feature. The design of the site is not yet finalized, and may include an outlet structure or weir for flow measurement and sample collection at the end of the bioswale. The City Hall Complex is a retrofit site and there is no reconstruction of existing buildings as there was at the Sylvan Center site. At the City Hall Complex the parking lots, corporation yard, and landscaping features will be replaced. The LID treatment features will be a simplified version of the Sylvan Center arrangement, and subsurface infiltration vaults are not planned. All urban runoff will pass through pervious pavement and bioswales and additional features such as rain gardens will also treat flow.

Figure 5. Example Drain Inlet at Existing City Hall Complex

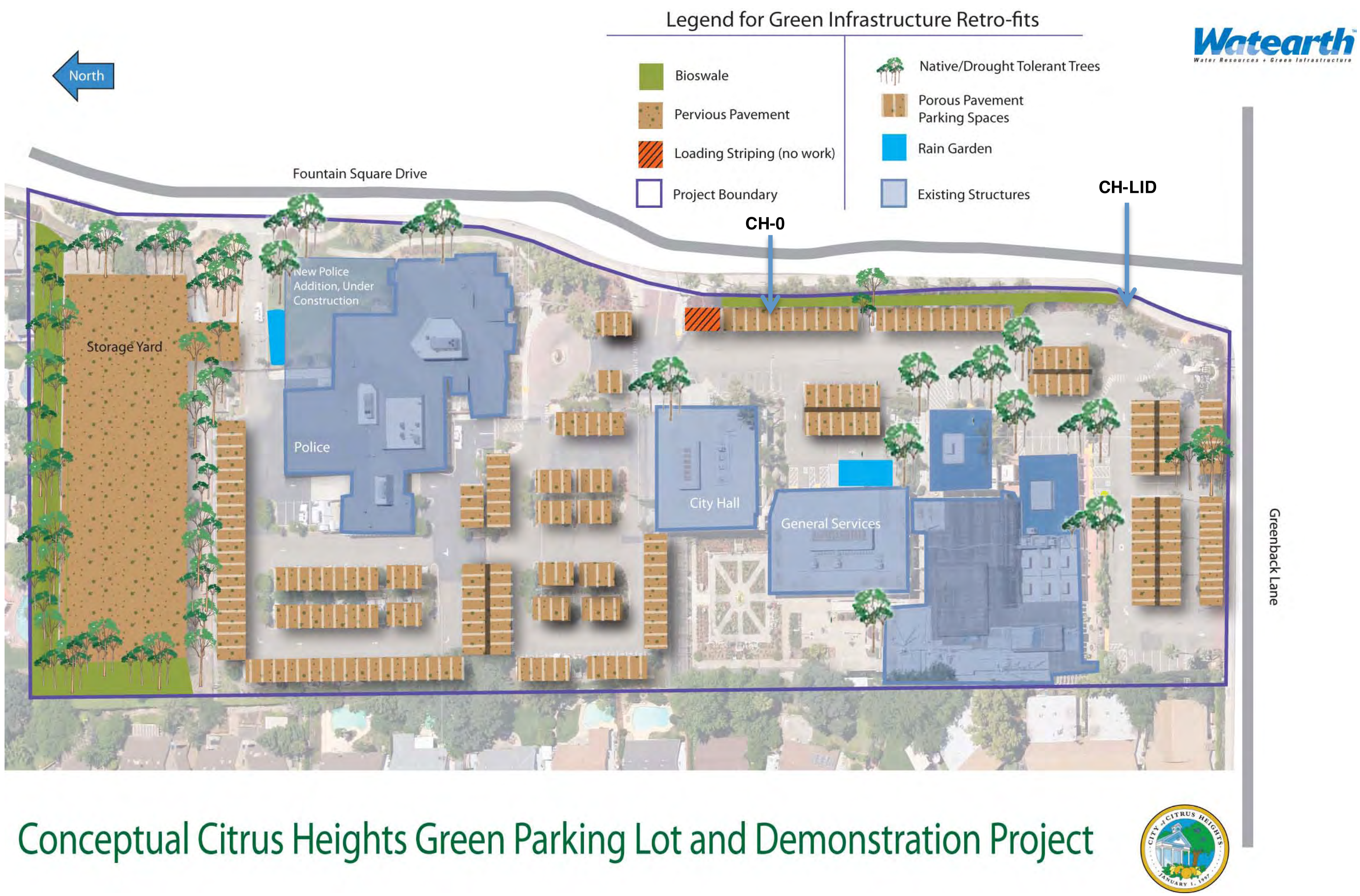

Figure 6. City Hall Complex Conceptual Drawing with Sampling Locations (modified from Watearth Conceptual Proposal and submitted as part of Proposition 84 Grant Application)

Figure 7. City Hall Complex Sampling Locations

MONITORING SCHEDULE

The Study will occur over the course of approximately two years, with monitoring efforts beginning October 2013 and ending April 2015. During the wet season (October through April) of each monitoring year, sensors will remain in-situ and operate continuously; auto-sampling will be conducted intermittently based on the occurrence of urban runoff entering the drain inlet. In up to five storm events samples will be collected using the autosampler and/or manual samples. Storms forecasted for larger amounts of precipitation and/or longer durations will be targeted. Auto-sampler sample collection will be limited to cases where there is outflow. Table 6 and Table 7 summarize the monitoring for all locations. Additional monitoring years may be added depending on the City Hall Complex site construction, initial study findings, available funding, and compliance with grant requirements.

Table 7. Summary of Proposed Methylmercury Control Study Monitoring

Location / Monitoring Type	Site ID[2]	Year 1	Year 2	Primary Equipment
Sylvan Center (SV)				
Prior to redevelopment[1]	SV-0	✓	✓	Auto-sampler, sensors, v-notch weir
LID	SV-LID	✓	✓	Auto-sampler, sensors, v-notch weir
City Hall Complex (CH)				
Prior to redevelopment	CH-0	✓		Auto-sampler, sensors, installed in pipe below grade
LID	CH-LID		✓	(Use same Year 1 equipment from pre-redevelopment City Hall Complex)

[1] Drainage area adjacent to the Sylvan Center
[2] Monitoring Point ID (see Figure 2, Figure 6, and Figure 7)

STATISTICAL ANALYSIS APPROACH

The Partnership will evaluate the study objective hypothesis with several statistical comparisons to compare both loads and concentrations of methylmercury exported to the MS4. The Partnership will evaluate the control objective using historical modeling tools previously developed by the Partnership.

Study Objective Evaluation

The Partnership will use the Wilcoxon Signed-Rank Test for paired analysis when samples from different sites are collected concurrently and the Mann-Whitney test for distributional comparisons between sites and historical data sets. The Partnership will compare methylmercury urban runoff concentrations and exported loads to test the hypothesis. The Partnership will calculate loads using data from the continuous probes and sample concentrations.

The Partnership will use the non-parametric Wilcoxon Signed-Rank Test to determine the statistical significance between paired samples of LID and non-LID methylmercury urban runoff concentrations and loads. Running the test produces a one-tailed p-value, which may be used to determine whether there is a statistically significant difference between two data sets if the p-value is less than 0.05 (95 percent confidence).

The Partnership will use Mann-Whitney distributional comparisons, visual inspection, and comparison of summary statistics to evaluate site differences when paired comparisons are not possible. Historical characterization data can also be used in this assessment of concentrations. Per acre annual exports of methylmercury loads will be calculated for comparisons between sites.

Control Objective Evaluation

To evaluate the control objective the Partnership will estimate the load removal benefit of LID redevelopment and retrofit on discharge load. Urban runoff methylmercury characterization and control is complicated in urban runoff by high variations in both flow volume and constituent concentrations. The Partnership has used the Watershed Treatment Model[18] (WTM) to estimate the amount of total mercury and methylmercury removed from urban runoff and to model control strategies and sources. The Partnership will modify this approach to determine the level of control strategies necessary to meet the WLA. The WTM is a conceptual model of loads removed in the watershed, evaluates structural and non-structural control effectiveness, includes Partnership data on completed activities as well as an inventory of methylmercury control strategies.

The Partnership used the previously described continuous simulation model to calculate discharged (exported) loads of methylmercury and could be further updated to evaluate the specific area within the Delta and hypothetical control measures.

The Partnership will consider these historical model approaches to evaluate methylmercury WLA compliance. The Partnership will simulate the application of LID and other methylmercury removal strategies to older urban development to determine the necessary level of implementation. Neither model considers biological, physical, or chemical mechanisms, but rather, empirically evaluated discharge concentrations in conjunction with runoff volume models.

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[18] Based on Center for Watershed Protection Watershed Treatment Model (WTM), which has developed modeling framework (<http://www.cwp.org/documents/cat_view/83-watershed-treatment-model.html>)

6.0 Quality Assurance Procedures

Include or summarize and reference quality assurance procedures that cover all aspects of sample collection, handling, and analyses for all parameters that will be measured.

This section presents quality assurance procedures for aqueous sample collection, handling, and analysis. Aqueous samples to be used for direct comparisons with methylmercury allocations will be analyzed as unfiltered. The Partnership will develop a complete sampling and analysis program (SAP) and quality assurance program plan (QAPP) as part of the Control Study and the grant funding requirements. The Partnership has developed quality assurance procedures for other monitoring projects and the following discussion provides a general description of QA procedure.

QUALITY CONTROL SAMPLES

The Partnership will collect quality control (QC) samples during each monitoring event. The locations with specific QC samples will rotate by event and specified in the detailed SAP and/or QAPP**.** Quality control sample results will be used for data evaluation and interpretation. Pre-season QC samples may include equipment and rinsate blanks, while monitoring event QC samples include field duplicates, composite field blanks, grab field blanks, matrix spike and matrix spike duplicates (MS/MSD).

Equipment and Rinsate Blanks

Prior to the first monitoring event, an equipment blank (blank water run through the cleaned tubing installed in the auto sampler) will be analyzed for the constituents listed in Table 8 (page 25). A composite bottle rinsate blank will also be collected and analyzed for the constituents listed in Table 8.

Field Duplicates

Composite sample field duplicates will be collected at one location per storm event. Duplicate samples measure the variability within the collected sample. The analytes measured in the duplicate samples will be the same as those measured in the environmental samples. The list of analytes is in Table 8.

Composite Field Blank

A composite field blank will be taken when the composite samples are collected, immediately following the termination of sampling. Blank samples measure any contamination that might have occurred during sample collection. Only the constituents that are most likely to attribute to contamination will be measured. Blank water will be poured into a clean carboy and will then be poured off into the samples listed in Table 8.

Grab Field Blank

Grab sample field blanks will be collected immediately prior to the normal collection of grab samples. Lab provided blank water will be poured into any intermediate container or sampling device and then transferred to the sample bottle. Constituents that require a grab field blank are listed in Table 8.

Matrix Spike and Matrix Spike Duplicates

MS/MSDs will be requested on specific composite samples for each storm event. MS/MSDs are used to evaluate the efficiency of analyte recovery in the sample matrix. Samples will be collected as normal, but additional volume will need to be collected for each requested analysis. The analytes that will require MS/MSD are listed in Table 8.

Table 8. Quality Control Samples

	QC Samples				
Parameters	**Equipment and Rinsate Blanks**	**Field Duplicates**	**Composite Blanks**	**Field Blanks**	**MS/MSDs**
Methylmercury	✓	✓	✓	✓	✓
Total mercury	✓	✓	✓	✓	✓
Total reactive mercury	✓	✓	✓	✓	✓
Total suspended solids		✓			
Suspended sediment concentration		✓			
Total dissolved solids		✓			
Total phosphorus		✓			
Total Kjeldahl nitrogen		✓			
Nitrate + Nitrite		✓			
Total organic carbon	✓	✓	✓	✓	
Dissolved organic carbon	✓	✓	✓	✓	
Filtered and unfiltered metals	✓	✓	✓	✓	✓
Sulfate		✓			

CLEAN SAMPLING PRACTICES

All sampling will be conducted in accordance with the procedures outlined in EPA Method 1669: Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels (USEPA 1996). Composite sample containers and equipment will be prepared using Method 1669, even though the method was not originally written to apply to composite sampling. The standard clean technique protocol detailed in EPA Method 1669 is as follows:

1. Samples are collected only into pre-cleaned sample bottles.
2. At least two persons, wearing clean, powder-free nitrile gloves at all times, are required on a sampling crew.
3. One person (“dirty hands”) touches and opens only the outer bag of all double-bagged items (such as sample bottles, tubing, strainers and lids), avoiding touching the inside of the bag.

4. The other person ("clean hands") reaches into the outer bag, opens the inner bag, and removes the clean item (sample bottle, tubing, lid, strainer, etc.).
5. After a grab sample is collected, or when a clean item must be re-bagged, it is done in the opposite order from which it was removed.
6. Clean, powder-free nitrile gloves are changed whenever something not known to be clean has been touched.
7. For this program, clean techniques must be employed whenever handling the suction tubing, strainers, double-bagged aliquot bottles, composite carboy or mercury and bacteriological grab sample bottles.
8. In order to reduce potential contamination, sample collection personnel will adhere to the following rules while collecting stormwater samples:
    a. No smoking.
    b. Never sample near a running vehicle. Do not park vehicles in immediate sample collection area (even non-running vehicles).
    c. Avoid allowing rainwater to drip from rain gear into sample bottles.
    d. Do not eat or drink during sample collection.
    e. Do not breathe, sneeze or cough in the direction of an open sample bottle.

DATA QUALITY EVALUATION PLAN

The Partnership annually prepares a data quality evaluation plan (DQEP)[19] that describes the evaluation steps and data qualification or rejection criteria. The Partnership developed database tools to automate most of the data evaluation steps to ensure consistency from year-to-year. The results are evaluated by the quality control manager prior to incorporation of data into the final database.

[19] Sacramento Stormwater Quality Partnership. *Data Quality Evaluation Plan*. Prepared by Larry Walker Associates. August 2012.

7.0 Project Evaluation and Data Sharing Plan

Describe the information that will be gathered and how it will be used to evaluate the effectiveness of the management practices or actions.

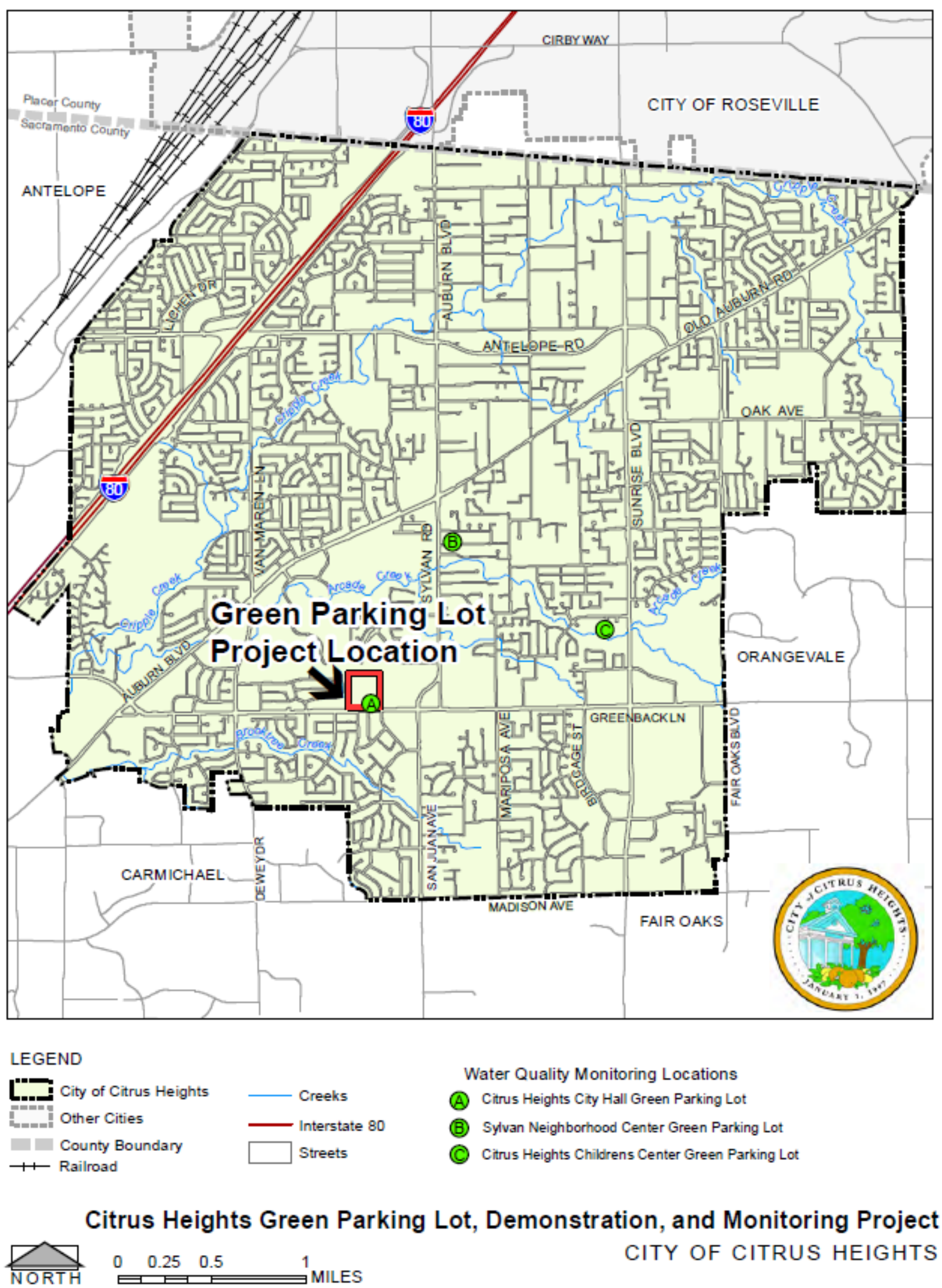
The proposed Work Plan is funded primarily by Proposition 84 funding from the State Water Resources Control Board (State Board) and the Partnership. The grant funding and contracting is expected to be completed prior to July 2013, and the reporting requirements for the grant are expected to include progress reports and a final report. The grant includes recognition of the TMDL requirements and coordination of the study elements according to the TMDL TAC comments. The Partnership expects that the reporting for the grant will be used as the basis for the Control Study progress and final report. The efforts outlined in this Work Plan will be presented in the Control Study progress report, which is due to the Regional Water Board and TAC in October 2015.

At the end of the Phase 1 Study period, the Partnership is required to report on effectiveness, feasibility, costs, and potential environmental effects of control methods evaluated and provide a plan and schedule for implementing methods to reduce methylmercury loads (Methylmercury Control Study Guidance, 2012). The Partnership expects to address the above requirements through this Control Study in the following manner:

a. The Partnership will evaluate the effectiveness of the Low Impact Development (LID) control measure based on the monitoring and load analysis for both LID and non-LID sites in this Control Study.
b. The Partnership will estimate the cost for implementation of LID as new development, retrofit and redevelopment projects to achieve compliance with the WLA. The Partnership will also consider, as data are available, ongoing maintenance costs for such implementation.
c. The Partnership will consider using data on other control features evaluated by the Stockton and Contra Costa MS4 agencies, other Partnership project data and readily available and applicable studies from other institutions and/or agencies.
d. The Partnership will identify potential environmental impacts of the proposed control method and the level of implementation to meet the WLA.
e. The Partnership will evaluate the overall feasibility of implementation of control measures to comply with the WLA, including a timeframe for compliance.

The Partnership database will archive and report monitoring data that is compatible with the California Data Exchange Network (CEDEN). The Partnership will share Study results that are relevant to other Central Valley dischargers including the Stockton and Contra Costa County MS4 agencies.

Appendix A: Map and Overview of LID Methylmercury Control Study Locations



The study locations are located within approximately one mile of each other. The locations were chosen since the City Hall Complex and planned Sylvan Center are examples of LID retrofit and redevelopment, respectively. The City Hall Complex site was selected for Proposition 84 Implementation funding, and contracting is now proceeding. Additionally, there are limited projects in the Citrus Heights urban area to choose from, especially projects located on accessible public locations.

SYLVAN CENTER

Redeveloped in 2012, the Sylvan Center is located at 7521 Community Drive in Citrus Heights, CA and covers a total of 16,319 square feet of area. In addition to various LID features (e.g., permeable pavers, a subsurface infiltration system, bioswales, vegetated swales, vegetated buffer strips, rainwater garden, native landscaping, and a rain barrel), the Sylvan Center development also includes a small, multipurpose building with a maximum capacity of 50 to 70 persons. The Sylvan Center is ideal for inclusion in the Study and specifically, for testing the study hypothesis and control objectives, since the location was redeveloped for the purpose of showcasing LID features to developers and the general public.

The designated non-LID drainage area adjacent to the Sylvan Center covers an area of less than 22,000 square feet (estimated), and includes urban residence structures with grassed yards and trees. Sharing a fence with the northern face of the Sylvan Center, the drainage area will provide a pre-redevelopment baseline for comparison with Sylvan Center area because the two locations are subject to the same hydrological conditions, are similar in size, and presumably share identical geological profiles (e.g., native underlying soils). The drainage area drains to the inlet of the northernmost vegetated swale on the Sylvan Center property.

CITY HALL COMPLEX

The City Hall Complex is located at 6237 Fountain Square Drive in Citrus Heights, CA. Like the Sylvan Center redevelopment, the planned City Hall Complex retrofit project will showcase LID features. Such features will include bioswales, pervious and porous pavement, rainwater gardens, and native/drought tolerant vegetation. The City Hall Complex was included in the Study for similar reasons as the Sylvan Center, and because Study results at City Hall Complex can be effectively compared against Study results obtained at local, existing predevelopment and LID redevelopment locations (i.e., the Sylvan Center and adjacent drainage area).